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The Challenges in Dimensional Metrology and Machine Tool Metrology

Reporter:

Duo Li

2017. 07. 15

挑战1： 微小尺寸测量

挑战2： 大尺寸测量

挑战3： 复杂曲面的测量

挑战4： 在线检测

挑战5： 多传感器融合

挑战6： 一维到多维



挑战7： 高深比的微结构

挑战8： 高曲率的自由曲面

挑战9： 内孔，内孔微结构

挑战10： AM 内部

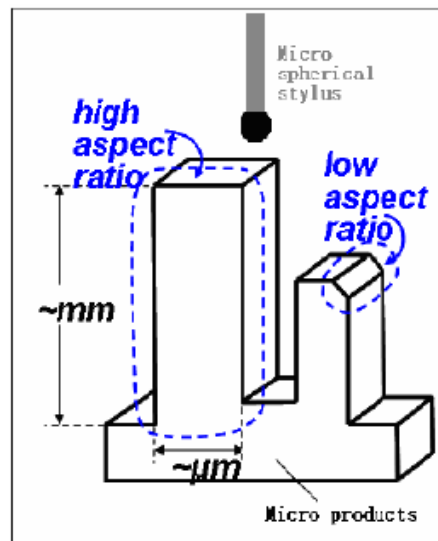
挑战11： Sensor net & Cloud

**挑战12： Real-time compensation
control**

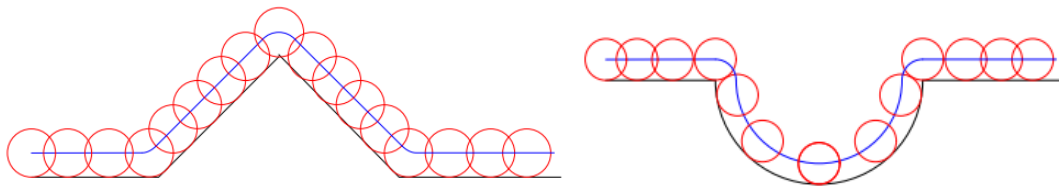
1、Micro scale measurement

接触探针测量

- 探针挠曲变形、制作误差
- 微结构补偿难以实现
- 测量速度慢
- 可能会造成表面损伤
- 无法测量复杂结构



探针测量示意图

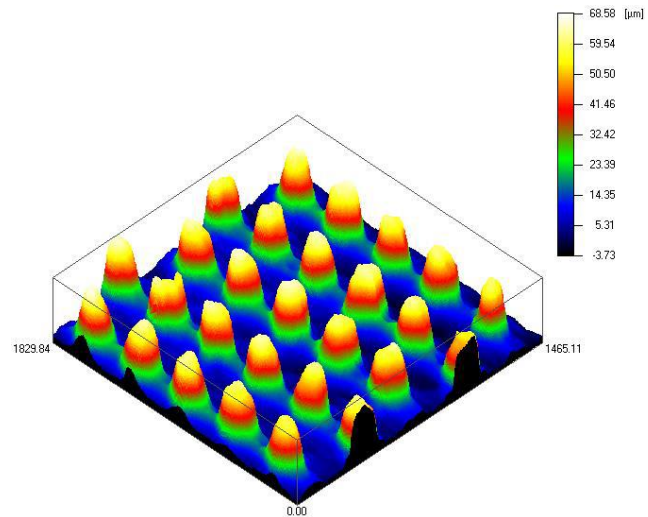


探针测量误差示意图

1、 Micro scale measurement

非接触测量

- 结构复杂
- 环境因素（温度、湿度）
- 蜂窝结构、内壁、盲孔测量
- 全反射



非接触测量示意图

2、 Large scale measurement

Metre-scale telescope and X-ray optics



3 Complex freeform measurement technology



高反射曲面零件的超精密加工技术已成为国防和现代高科技领域的**前沿研究方向**,准确测量和评价超精密加工高反射曲面零件的三维形貌,研究表面几何特性与使用性能的关系,对提高加工表面的质量和产品性能具有重要的意义。

现有的接触式测量方法具有测量速度慢、易划伤测量表面的缺点,而单一的光学非接触测量方法**难以**完成对大面形或曲率较大的高反射曲面零件三维形貌的高精度测量。

展望: 可综合运用空间曲面共轭啮合原理、牛顿迭代法、矢量分析法、基于误差建模仿真法等理论和方法,利用 **UG**建模、**ADMAS**仿真、**Matlab**编程等工具,开发设计一套可行的测量方案。

4 Online Inspection Technology Integrated With NC Machine Tools

研究背景



挑战

高精度

复杂大型零件

精度评价

加工—测量—修整

数控机床

4 Online Inspection Technology Integrated With NC Machine Tools

机床在线测量过程

Ref.: Li Jianguang, Aero. Manu. Tech. (2014)

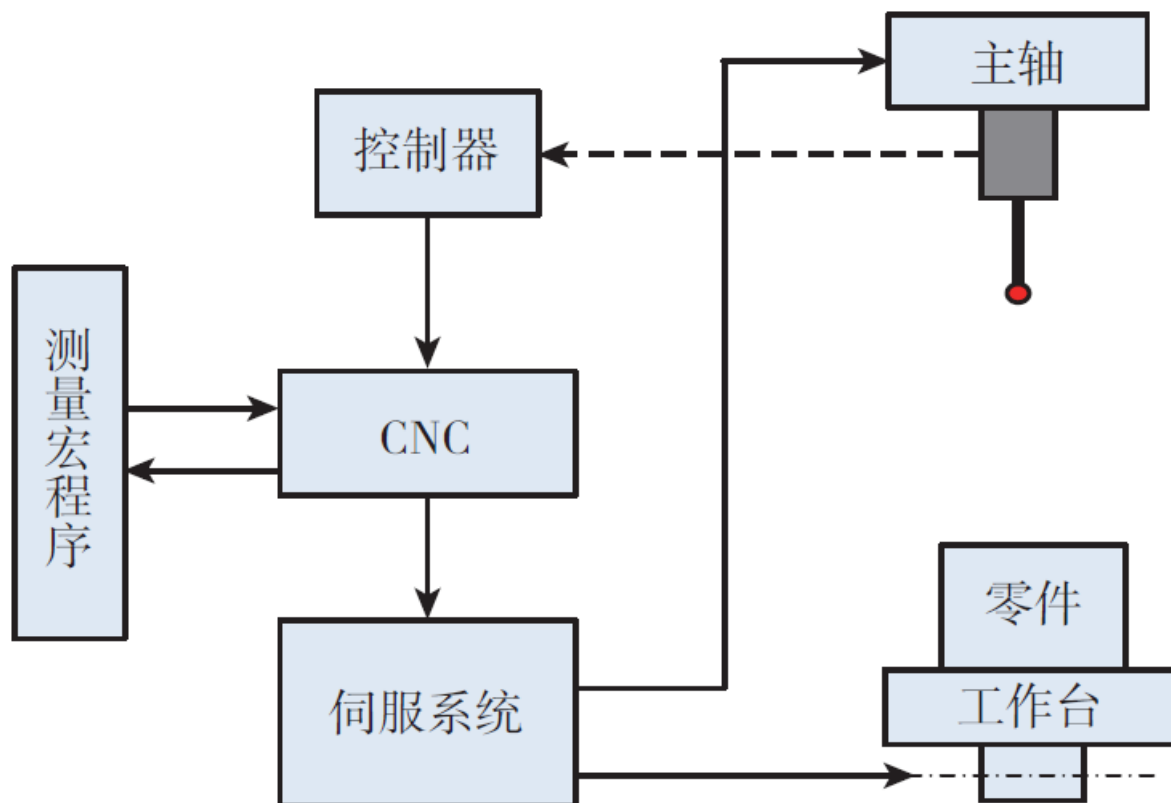
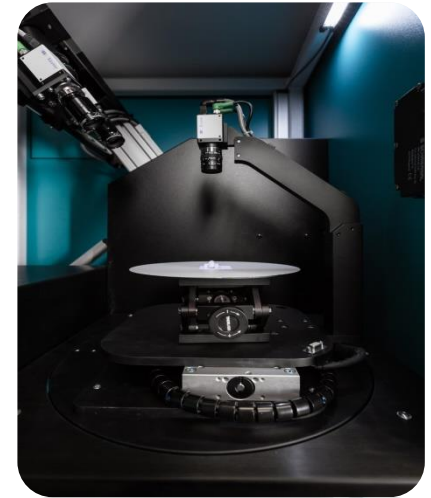
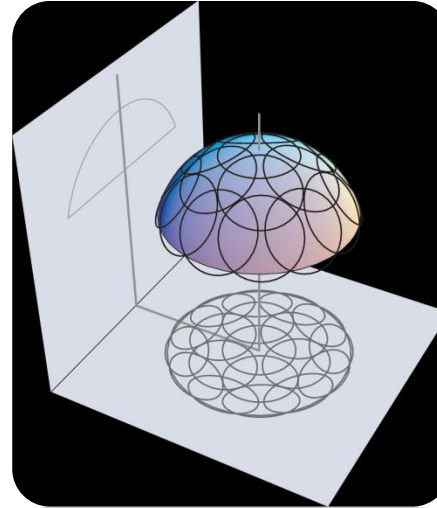
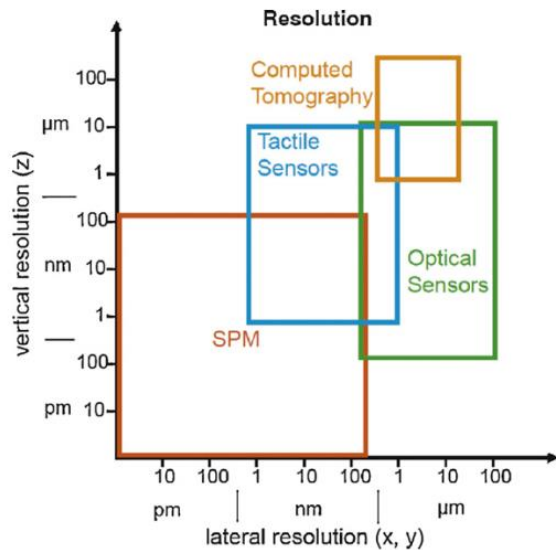
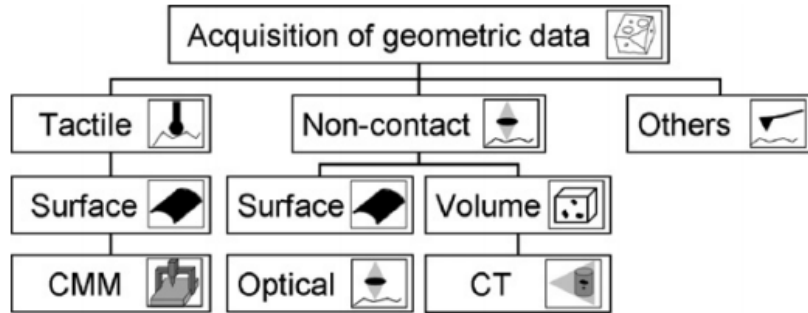


图2 数控机床在线测量系统^[8]

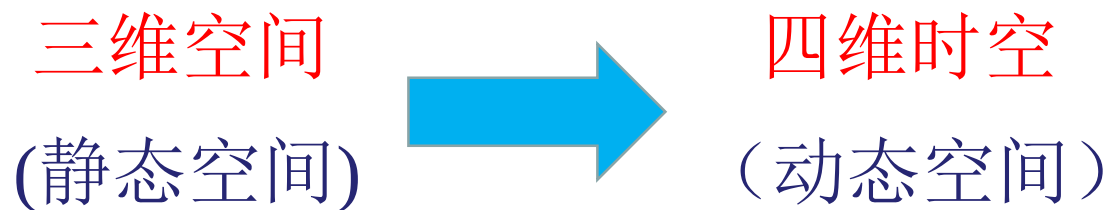
5、 Multi-sensor fusion

For dimension metrology



6、One dimensional to Multidimensional

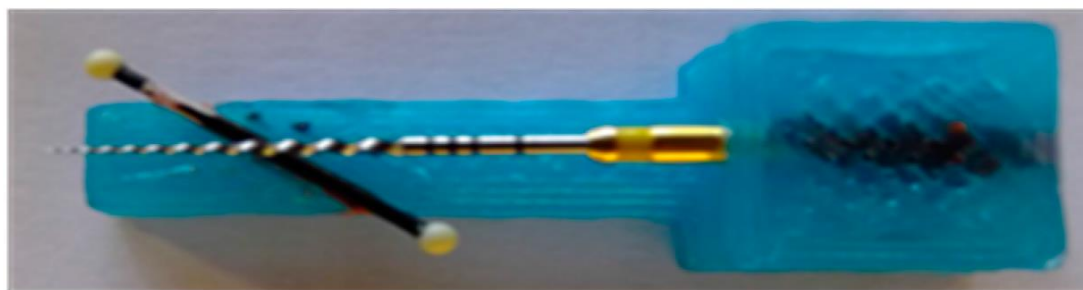
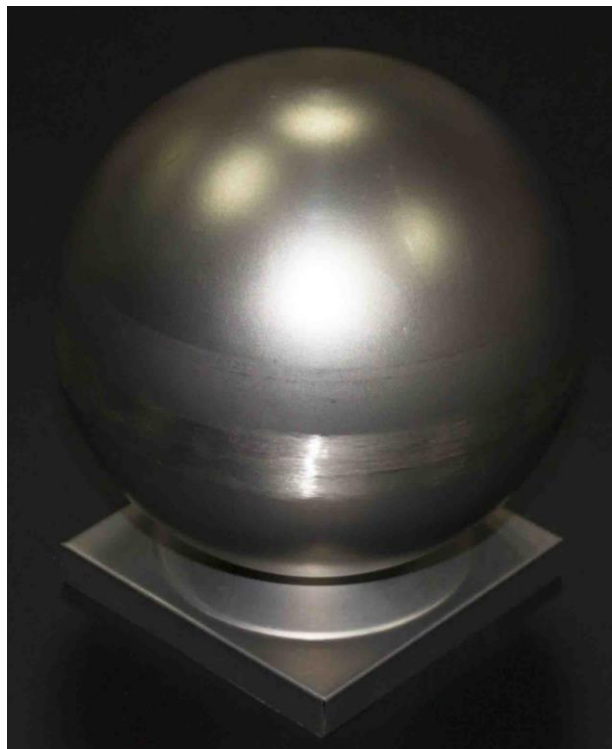
任何一个物体在空间都有6各自由度，即 x, y, z 方向的平动和绕3各方向的转动。（若考虑时间维度的话，有多了一个时间维度的演变，又增加一个自由度），随着复杂零件、工具的产生及其应用，传统一维的检测受到一定的限制。



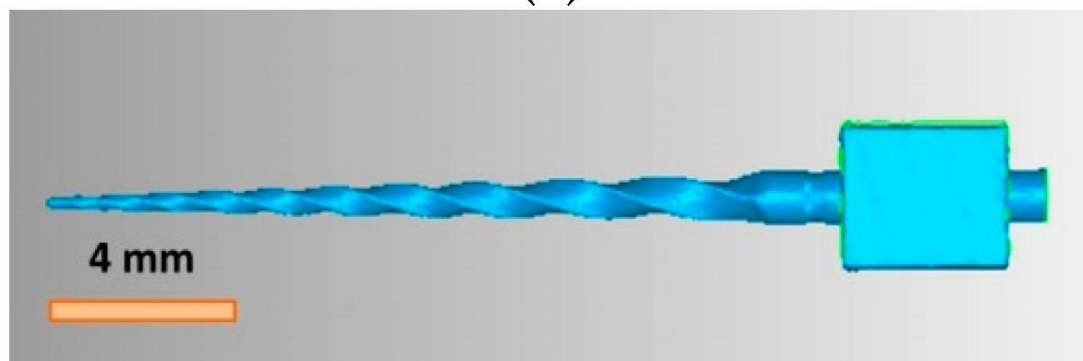


1、叶片形貌、结构尺寸、孔、型腔的角度及自由曲面的矢量等等共同影响着叶轮的加工质量。

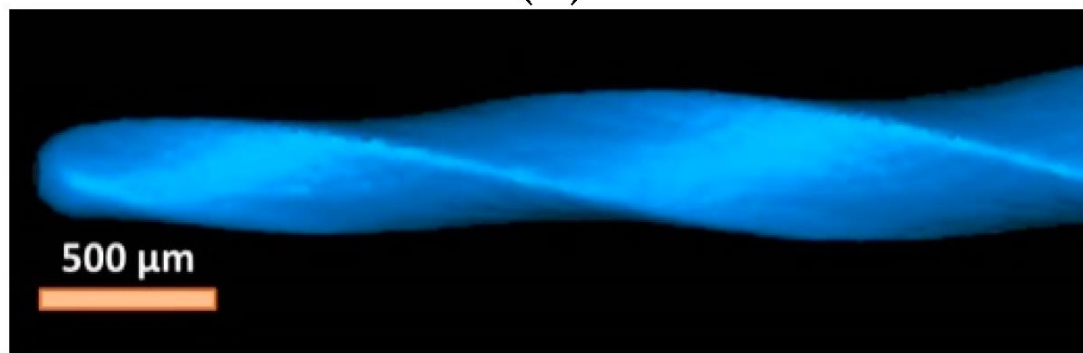
2、残余应力、结构强度、材料特性等随加工过程变化也在发生演变。



(a)



(b)



(c)